

Claims

1. An air monitoring system, comprising:
 - an air monitoring unit including at least one sensor for acquiring air quality parameter data; and
 - a computer including an expert system for controlling the air monitoring unit based at least in part on the acquired air quality data.
2. The air monitoring system of claim 1, wherein the expert system is adapted to analyze data from the air monitoring unit based at least in part on the acquired air quality data.
3. The air monitoring system of claim 1, further comprising:
 - a monitor for environmental data;
 - wherein the expert system is adapted to provide an air quality analysis based at least in part on the acquired air quality data and the environmental data.
4. The air monitoring system of claim 1, wherein:
 - the expert system is adapted to configure a test to be performed by the air monitoring unit including the location of the test and the time duration for the test.
5. The air monitoring system of claim 1, wherein the expert system is adapted to provide a recommendation for improving the air quality parameter data.
6. The air monitoring system of claim 1, wherein the unit is portable.
7. The air monitoring system of claim 1, wherein the expert system is provided within the air monitoring unit.
8. The air monitoring system of claim 1, wherein the air monitoring unit includes a program for acquiring the air quality parameter data and the expert system is adapted to modifying the program.

9. An air monitoring system, comprising:
 - an air monitoring unit including at least one sensor for measuring air quality parameter data;
 - wherein the air monitoring unit is adapted to download information from a remote data center through a communication link to modify the function of the air monitoring unit.
10. The air monitoring system of claim 9, wherein the air monitoring unit is adapted to upload air quality parameter data and download information automatically from a remote data center through a communication link.
11. The air monitoring system of claim 9, wherein the air monitoring unit is adapted to download additional characteristics regarding a structure being sensed from the remote data center.
12. The air monitoring system of claim 9, wherein the air monitoring unit is adapted to download information capable of commanding the air monitoring unit to measure air quality parameter data at different times.
13. The air monitoring system of claim 9, wherein the air monitoring unit is programmed with operational parameters.
14. The air monitoring system of claim 13, wherein the air monitoring unit is adapted to download information from the remote data center capable of changing the operational parameters of the air monitoring unit.
15. The air monitoring system of claim 9, wherein the communications link includes an Internet.

16. An air monitoring system, comprising:

an air monitoring unit including at least one sensor for measuring air quality parameter data, and a computer for storing the data received from the sensor;

a remote data center including a database for storing the air quality parameter data and receiving inputted characteristics, and an expert system interactive with the air quality parameter data for analysis of the data in relation to certain inputted characteristics; and

a communication link between the data center and the air monitoring unit;

wherein the remote data center downloads information to the air monitoring unit through the communication link to modify the function of the air monitoring unit.

17. The air monitoring system of claim 16, wherein the expert system generates the information, and is adapted to download the information to the air monitoring unit.

18. The air monitoring system of claim 16, wherein the expert system is adapted to download information to the air monitoring unit to command the air monitoring unit to take a grab sample.

19. The air monitoring system of claim 16, wherein the air monitoring unit includes operational parameters, and the expert system is adapted to download information to the unit to change the operational parameters.

20. The air monitoring system of claim 16, wherein the air monitoring unit includes a program to instruct the air monitoring unit in measuring air quality parameter data, and the expert system is adapted to download information to the air monitoring unit to change the program.

21. The air monitoring system of claim 16, wherein the air monitoring unit includes a set-up parameter, and the expert system is adapted to change the set-up parameter in the air monitoring unit.

22. The air monitoring system of claim 16, wherein the communications link includes an Internet.

23. An air monitoring unit, comprising:

at least one removable card including at least one sensor and a shroud enclosing the sensor; and

a conduit connected to the shroud.

24. The air monitor unit of claim 23, further comprising a closed air path at least partially through the shroud.

25. The air monitor unit of claim 24, wherein at least one sensor is located within the closed air path.

26. The air monitor unit of claim 25, wherein the shroud has an inlet within the closed air path to allow air into the shroud and an outlet exiting the closed air path to allow the air out of the shroud.

27. The air monitor unit of claim 26, wherein the shroud surrounds the sensor and a plenum is located within the shroud adjacent the air inlet to direct air substantially smoothly through the shroud.

28. The air monitoring unit of claim 23, further comprising a standardized electrical interface to support at least two sensor cards.

29. The air monitoring unit of claim 23, further comprising a sensor for counting airborne particles of one or more size ranges; and having at least one sensor for air monitoring purposes.

30. The air monitoring unit of claim 23, further comprising a sensor for monitoring radon; and having at least one sensor for air monitoring purposes.

31. An air monitoring system, comprising:
 - an air monitoring unit including a grab sampler contained within the air monitoring unit for acquiring an air sample;
 - a remote control unit for controlling the air monitoring unit; and
 - a communications link between the remote control unit and the air monitoring unit;

wherein the remote control unit is adapted to download a command to the air monitoring unit to trigger the grab sampler to acquire an air sample.
32. The air monitoring unit of claim 31, wherein the grab sampler includes a sorbent tube.
33. The air monitoring unit of claim 31, wherein the grab sampler includes a container for holding a sample of air.
34. Apparatus comprising:
 - an air monitoring system having at least one sensor for acquiring air quality data at a selected indoor location; and
 - a computer comprising an expert system for analyzing the acquired air quality data and reaching a conclusion regarding air quality of the selected indoor location.
35. Apparatus as defined in claim 34, wherein the computer comprising the expert system is a part of the air monitoring system.
36. Apparatus as defined in claim 34, wherein the computer comprising the expert system is remotely located from said air monitoring system.
37. Apparatus as defined in claim 34, wherein said means for analyzing the acquired air quality data further comprises means for analyzing information representative of the selected indoor location in reaching said conclusion.

38. Apparatus as defined in claim 34, wherein said expert system comprises two or more experts for determining intermediate results and an expert coordinator for combining said intermediate results to reach said conclusion.

39. Apparatus as defined in claim 34, wherein said expert system includes means for making a recommendation for improving the air quality of the selected indoor location.

40. Apparatus as defined in claim 34, wherein said expert system includes means for controlling operations of said air monitoring system.

41. Apparatus as defined in claim 34, wherein said expert system includes means for modifying operation of the air monitoring system in response to the acquired sensor data.

42. Apparatus as defined in claim 34, wherein said air monitoring system further comprises an air sampling device and wherein said expert system includes means for issuing a command to said air sampling device to acquire an air sample in response to the acquired sensor data meeting a predetermined criteria.

43. Apparatus as defined in claim 34, wherein said air monitoring system comprises a portable air monitoring unit that is easily movable to different selected indoor locations.

44. Apparatus as defined in claim 34, wherein said air monitoring system comprises an installed system for monitoring air quality in multiple indoor locations.

45. Apparatus comprising:
an air monitoring system including at least one sensor for acquiring air quality data at a selected indoor location; and
a control site for controlling operation of the air monitoring system through an Internet.

46. Apparatus as defined in claim 45, wherein said control site includes means responsive to information representative of the selected indoor location for downloading a customized operating program to the air monitoring system.

47. Apparatus as defined in claim 45, wherein said control site includes means responsive to information representative of the selected indoor location for downloading customized operating parameters to the air monitoring system.

48. Apparatus as defined in claim 45, wherein said control site includes means for modifying the operation of the air monitoring system in response to the acquired sensor data.

49. Apparatus as defined in claim 45, wherein said control site further comprises an expert system for analyzing the acquired sensor data and reaching a conclusion regarding air quality of the selected indoor location.

50. Apparatus as defined in claim 45, wherein said air monitoring system further comprises an air sampling device and wherein said control site includes means for issuing a command to said air sampling device to acquire an air sample in response to the acquired sensor data meeting a predetermined criteria.

51. Apparatus as defined in claim 45, wherein said air monitoring system includes a portable air monitoring unit that is movable to different indoor locations.

52. Apparatus as defined in claim 45, wherein said air monitoring system includes an installed system for monitoring air quality in multiple indoor locations.

53. An air monitoring unit comprising a plurality of sensors for acquiring sensor data representative of air quality at a selected indoor location and a control unit adapted for receiving through the Internet a customized operating program for monitoring air quality at the selected indoor location.

54. A method for monitoring indoor air quality comprising the steps of:
providing information representative of a selected indoor location to a remotely
located control unit;
positioning an air quality monitoring unit in the selected indoor location;
downloading customized operating information from the control unit to the air
quality monitoring unit; and
monitoring the air quality at the selected location in accordance with the
customized operating information.

55. A method as defined in claim 54, wherein the step of providing information
comprises entering the information at a personal computer and transmitting the information from
the personal computer to the remotely located control unit.

56. A method as defined in claim 54, wherein the step of positioning an air quality
monitoring unit comprises positioning a portable air monitoring unit at different selected
locations in a building.

57. A method as defined in claim 54, wherein the step of downloading customized
operating information comprises downloading a customized operating program to the air quality
monitoring unit.

58. A method as defined in claim 54, wherein the step of downloading customized
operating information comprises downloading customized operating parameters to the air quality
monitoring unit.

59. A method as defined in claim 54, wherein the step of downloading customized
operating information comprises downloading a command for initiating acquisition of an air
sample.

60. A method as defined in claim 54, wherein the step of downloading customized operating information comprises downloading modifications to previously downloaded operating information.

61. A method as defined in claim 54, wherein the step of downloading customized operating information is performed by transmitting the customized operating information through the Internet.

62. A method as defined in claim 54, further comprising the step of uploading acquired air quality data from the air quality monitoring unit to the remotely located control unit.

63. A sensor card for use in an air quality monitoring system, comprising:
a card having a connector for electrical connection to the air quality monitoring system;

an air quality sensor mounted on said card for providing sensor data through said connector to the air quality monitoring system; and

a shroud mounted on said card for defining an air flow path to said air quality sensor, said shroud having an inlet and outlet.

64. A sensor card as defined in claim 63, further comprising a shroud mounted on said card for defining an air flow path to said air quality sensor, said shroud having an inlet and an outlet.

65. A sensor card as defined in claim 63, further comprising a perforated divider mounted in said shroud for controlling air flow through said shroud.

66. A sensor card as defined in claim 63, further comprising means for producing a substantially laminar air flow through said shroud.

67. A sensor card as defined in claim 63, wherein the inlet and outlet of said shroud are provided with quick disconnect connectors.

68. A sensor card as defined in claim 63, further comprising electronic circuitry mounted on said card and coupled to said air quality sensor.
69. A sensor card as defined in claim 68, wherein said electronic circuitry provides an electrical interface to the air quality monitoring unit.
70. An air quality monitoring system comprising:
 - at least one air quality sensor for acquiring sensor data at a selected indoor location;
 - a control unit for generating a grab sample command in response to the acquired sensor data meeting a predetermined criteria; and
 - a grab sample unit for acquiring an air sample at the selected indoor location in response to the grab sample command from the control unit.
71. An air quality monitoring system as defined in claim 70, wherein said control unit is located in proximity to the air quality sensor and the grab sample unit.
72. An air quality monitoring system as defined in claim 70, wherein said control unit is remotely located from the air quality sensor and the grab sample unit.
73. An air quality monitoring system as defined in claim 72, wherein the control unit communicates with the air quality sensor and the grab sample unit through the Internet.
74. An air quality monitoring system as defined in claim 70, wherein said grab sample unit includes a filter unit for removing particles from the air sample.
75. An air quality monitoring system as defined in claim 70, wherein said grab sample unit comprise a sorbent material for removing gases from the air sample.
76. An air quality monitoring system as defined in claim 70, wherein said grab sample unit is configured for acquiring multiple air samples in response to multiple grab sample commands from said control unit.

77. An air quality monitoring system as defined in claim 70, wherein said control unit comprises an expert system for analyzing the acquired sensor data and generating the grab sample command.

78. An air quality monitoring unit comprising:
a housing;
a plurality of easily removable air quality sensors mounted in said housing;
a programmable control unit having an interface to said air quality sensors,
wherein said control unit is programmable so as to customize the air quality monitoring unit for
operation with different sensors; and
a manifold for transporting air from an inlet to said air quality sensor;
wherein said control unit includes an Internet interface for receiving operating
information through the Internet.

79. An air quality monitoring unit as defined in claim 78, wherein at least one of
said air quality sensors is mounted on a sensor card plugged into a card cage in said housing.

80. An air quality monitoring unit as defined in claim 78, further comprising a
manifold for transporting air from an inlet to said air quality sensors.

81. An air quality monitoring unit as defined in claim 78 further comprising at least
one sensor located in said manifold near said inlet for sensing a parameter that changes rapidly.

82. An air quality monitoring unit as defined in claim 78 further comprising a
vacuum pump for drawing air through said inlet to said plurality of air quality sensors.

83. An air quality monitoring unit as defined in claim 78, further comprising a grab
sample unit for acquiring an air sample in response to a grab sample command from said control
unit.

84. An air quality monitoring unit as defined in claim 78, wherein said control unit
includes an Internet interface for receiving operating information through the Internet.

85. An air quality monitoring unit as defined in claim 78, wherein said housing is readily movable to different monitoring locations.

86. An air quality monitoring unit as defined in claim 78, wherein said control unit includes a GPS system for providing location information to the control unit.

87. An air quality monitoring unit as defined in claim 78, further comprising a sensor interface card coupled between said air quality sensors and said control unit.

88. The air monitoring system of claim 1 wherein expert system is used at least in part to detect anomalies in the air monitoring unit.

89. The air monitoring system of claim 1 wherein expert system is used at least in part to detect data that is tampered or faulty.

90. The air monitoring system of claim 9, wherein the air monitoring unit includes a program to instruct the air monitoring unit in measuring air quality parameter data, and the air monitoring unit is adapted to download information from the remote data center to change the program.

91. The air monitoring system of claim 9, wherein the air monitoring unit includes a set-up parameter, and the air monitoring unit is adapted to download information from the remote data center to change the set-up parameter in the air monitoring unit.

92. The air monitoring system of claim 10, wherein the air monitoring unit is programmed to upload air quality parameter data automatically at periodic intervals.

93. An air monitoring system, comprising:
an air monitoring unit including at least one sensor for measuring air quality parameter data;
wherein the air monitoring unit is adapted to download information from a remote control unit through a communication link in order to create at least one database location within the air monitoring unit to store air quality parameter data from a given building area that is linked to corresponding database locations in the remote control unit to which the air quality parameter data from that area will be stored.

94. The air monitoring system of claim 15, wherein the downloaded information contains in part a user supplied label for the building area to be measured.

95. The air monitoring unit of claim 25, further comprising at least one additional removable card including at least one air monitoring sensor located within the closed air path.

96. The air monitoring unit of claim 25, further comprising at least one additional fixed card including at least one air monitoring sensor located within the closed air path.

97. The air monitoring system of claim 31, wherein the communications link includes an Internet.

98. The air monitoring system of claim 31, wherein the communications link includes a local area network.

99. The air monitoring system of claim 31, wherein the command from the remote control unit is initiated by manual control.

100. The air monitoring system of claim 31, wherein the command is initiated based on at least one of commands or input from another building system.

101. The air monitoring system of claim 100, wherein the other building system is a fire alarm system.

102. The air monitoring system of claim 100, wherein the other building system is a building control system.

103. The air monitoring system of claim 100, wherein the other building system is a building ventilation system.

104. Apparatus as defined in claim 34, wherein the expert system operates at least on occupant symptom data from the building location.

105. Apparatus as defined in claim 34, wherein the expert system operates at least on user supplied information about the building location.

106. Apparatus as defined in claim 34, wherein the expert system operates at least on historical indoor air quality data in addition to current indoor air quality data from the building location.

107. Apparatus as defined in claim 34, wherein the expert system can learn or improve its effectiveness by accepting user feedback on the effectiveness of its conclusions.

108. Apparatus as defined in claim 107, wherein data mining is used to assist the learning process.

109. Apparatus as defined in claim 34, wherein the expert system includes at least rule based methods.

110. Apparatus as defined in claim 34, wherein the expert system includes at least case based methods.

111. Apparatus as defined in claim 34, wherein the expert system includes at least pattern recognition methods.

112. Apparatus as defined in claim 34, wherein the expert system includes at least fuzzy logic.

113. Apparatus as defined in claim 34, wherein the expert system uses two or more of rule, case, or pattern recognition based methods and a means to combine their results.

114. Apparatus as defined in claim 34, wherein the expert system uses blackboarding techniques to combine multiple expert system methods.

115. Apparatus as defined in claim 114, wherein a web session is used as the expert system blackboard.

116. Apparatus as defined in claim 45, wherein said air monitoring system includes a GPS for determining the location automatically of the selected indoor space.

117. A method for determining the location of an air monitoring unit, comprising the steps of:

providing a GPS in an air monitoring unit;

determining the location of the air monitoring unit from previously downloaded test locations, using information from the GPS.

118. An air quality monitoring system as defined in claim 74, wherein said grab sample unit is commanded based at least on data from a TVOC sensor.

119. An air quality monitoring system as defined in claim 75, wherein said grab sample unit is commanded based at least on data from a particle sensor.

120. An air quality monitoring system as defined in claim 70, wherein said acquired sensor data includes data from at least two sensors.

121. An air quality monitoring unit as defined in claim 78, wherein the air monitoring unit also includes other air quality sensors that are not easily removable.

122. An air monitoring system, comprising:

an air monitoring unit including at least one sensor for measuring air quality parameter data; and
an Internet interface accessible through a wireless communication link,
wherein the air monitoring unit is adapted to be in communication with the Internet interface through the wireless communication link.

123. The air monitoring system of claim 122 wherein the air monitoring unit is adapted to upload information to the Internet interface through the wireless communication link.

124. The air quality monitoring system as of claim 122, wherein air quality parameter data is uploaded automatically on a periodic basis.

125. The air monitoring system of claim 122 wherein the air monitoring unit is adapted to download information from the Internet interface through the wireless communication link.

126. The air monitoring system of claim 122 wherein the air monitoring unit is adapted to upload information to the Internet interface from the air monitoring unit and download information to the air monitoring unit from the Internet interface through the wireless communication link.

127. The air monitoring system of claim 122 further comprising:
a base unit, wherein the base station is adapted to be connected to the Internet interface by a local wireless communication link.

128. The air monitoring unit of claim 127, wherein the local wireless communication link is connected to a phone line.

129. The air monitoring unit of claim 122, wherein the local wireless communications link is connected to an Ethernet system.

130. The air monitoring unit of claim 122 wherein the wireless communications link is connected to an Ethernet system.

131. The air monitoring unit of claim 122 wherein the wireless communications link is connected to a local area network.

132. The air monitoring unit of claim 122 wherein the wireless communications link is connected to a building control network.

133. The air monitoring unit of claim 122 wherein the air monitoring unit includes at least two gas sensors.

134. The air monitoring unit of claim 122 wherein the air monitoring unit includes at least a carbon dioxide sensor and a particle sensor.

135. The air monitoring unit of claim 122, wherein the wireless communication link includes a cellular phone.

136. A method of making an indoor air quality scorecard, the method comprising the steps of:

collecting indoor air quality data for at least two distinct areas;
comparing the indoor air quality data of the at least two distinct areas to each other; and
ranking the distinct areas according to a criteria based on their indoor air quality data.

137. The method of claim 136, wherein the step of collecting comprises measuring various air quality parameters.

138. The method of claim 137 wherein the step of collecting data involves sending data via an Internet to a database.

139. The method of claim 137 wherein the step of collecting data involves data from at least a carbon dioxide sensor, a particle sensor, and a humidity sensor.

140. The method of claim 137, wherein the step of comparing comprises combining multiple air quality parameters into at least one index.

141. The method of claim 140 wherein the step of ranking comprises ordering the distinct areas based on the index for each distinct area.

142. The method of claim 137, where the step of comparing comprises combining multiple air quality parameters into at least one subindex.

143. The method of claim 142 wherein the step of comparing comprises at least three subindices.

144. The method of claim 143 wherein the step of comparing comprises rating the distinct areas with indices for one or more of comfort, healthiness and operational efficiency.

145. The method of claim 143 wherein the step of comparing comprises combining the subindices in a weighted manner to form an index for each distinct area.

146. The method of claim 145 wherein the step of ranking comprises ordering the distinct areas based on the index for each distinct area.

147. The method of claim 137 wherein the step of comparing comprises combining the indoor air quality data in a weighted manner using the measurements of the air quality parameters.

148. The method of claim 136 wherein the step of comparing comprises using an expert system to compare the indoor air quality data.

149. The method of claim 136 wherein the distinct areas are separate buildings.